VOL. XXXI JULY, 1915 No. 1

JOURNAL

OF THE

ELISHA MITCHELL SCIENTIFIC SOCIETY

ISSUED QUARTERLY

CHAPEL HILL, N. C., U. S. A.

TO BE ENTERED AT THE POSTOFFICE AS SECOND-CLASS MATTER

Elisha Mitchell Scientific Society

J. M. BELL, President
A. H. PATTERSON, Vice-President
T. F. HICKERSON, Recording Sec. F. P. VENABLE, Perm. Sec.

EDITORS OF THE JOURNAL:
W. C. COKER
J. M. BELL - A. H. PATTERSON

CONTENTS

PROCEEDINGS OF THE FOURTEENTH ANNUAL MEETING OF THE NORTH CAROLINA ACADEMY OF SCIENCE . . 1

AN OUTLINE OF MODERN WORK BEARING OF THE THEORY OF DESCENT—*J. J. Wolfe* 12

RADIO-ACTIVITY AND THE PERIODIC SYSTEM 27

A LIST OF HOMOPTERA IN NORTH CAROLINA—*Z. P. Metcalf* 35

THE SEASONAL DISTRIBUTION OF THE ARMY-WORM MOTH AT RALEIGH—*C. S. Brimley* 61

Journal of the Elisha Mitchell Scientific Society—Quarterly. Price $2.00 per year; single numbers 50 cents. Most numbers of former volumes can be supplied. Direct all correspondence to the Editors, at University of North Carolina, Chapel Hill, N. C.

JOURNAL

OF THE

Elisha Mitchell Scientific Society

VOLUME XXXI JULY, 1915 No. 1

PROCEEDINGS OF THE FOURTEENTH ANNUAL MEETING OF THE NORTH CAROLINA ACADEMY OF SCIENCE HELD AT WAKE FOREST COLLEGE, WAKE FOREST, N. C., FRIDAY AND SATURDAY, APRIL 30-MAY 1, 1915

The Academy was called to order by President J. J. Wolfe at 2:50 P. M., with 21 members and 10 visitors present. Reading of papers was begun and continued until 9 had been read and discussed. President Wolfe then announced the following committees: Nominations, C. Cobb, F. Sherman, Jr., J. F. Lanneau; Auditing, A. S. Wheeler, B. Cunningham, C. S. Brimley; Resolutions, W. A. Withers, A. H. Patterson, Z. P. Metcalf. The Academy then adjourned at 5:30.

The Executive Committee—President Wolfe, Vice-President Patterson, Secretary Gudger, *ex officio,* and Prof. W. A. Withers—held its annual meeting immediately after adjournment. The following applicants for membership were unanimously elected:

1. F. E. Carruth, Assistant in Chemistry, N. C. Experiment Station, West Raleigh.
2. R. H. Field, Assistant in Zoology and Entomology, State Agricultural and Mechanical College, West Raleigh.
3. S. W. Geiser, Professor of Biology, Guilford College.
4. T. F. Hickerson, Professor of Civil Engineering, University of North Carolina.

5. R. W. Leiby, Assistant Entomologist, State Department of Agriculture, Raleigh.

6. Mary Lyon, Professor of Science, Southern Presbyterian College, Red Springs.

7. E. T. Miller, Professor of Engineering, Trinity College.

8. J. K. Plummer, Soil Chemist, State Department of Agriculture, Raleigh.

9. Elizabeth B. Potwine, Instructor in Mathematics, State Normal College, Greensboro.

10. H. Spencer, Assistant in Zoology and Entomology, State Agricultural and Mechanical College, West Raleigh.

A letter from the Secretary of the Faculty of the A. & M. College was then read inviting the Academy to hold its next annual meeting at that institution in 1916. On motion the invitation was unanimously accepted. The Secretary then gave his report as to (1) membership, (2) finances, and (3) the matter of raising the dues. These matters were discussed at some length and recommended to the careful consideration of the Academy at its annual business meeting. The Committee then adjourned.

At 8 P. M. the Academy met in evening session in Wingate Memorial Hall. After a cordial welcome to Wake Forest College delivered by Dean Charles E. Brewer, President J. J. Wolfe delivered his presidential address, "The Status of the Theory of Descent." Next Prof. John F. Lanneau delivered a lecture on "The Cosmoid" with a demonstration of an apparatus of his own design. Following him Prof. A. H. Patterson gave a demonstration and explanation of the working of a new form of humidifier of North Carolina make. His title was "The Importance of Humidity in Health and the Arts."

At 9:20 Saturday morning the Academy convened in annual business meeting with 19 members present. The minutes of last meeting were read and approved and the report of the Executive Committee as to the election of new members and the choice of the next place of meeting was had. Notice was ordered to be entered in the Proceedings of the

invitation to the recent inauguration of Prof. E. K. Graham as president of the University of North Carolina, and of our representation there by President Wolfe. The Secretary then made his annual report as to membership; that on January 1, 1914, there were 78 members, and that during the year there were 4 new members elected and 13 dropped because of removal from the State, non-payment of dues, etc., leaving 69 members in good standing on January 1, 1915.

The Treasurer then read his itemized financial statements as follows:

REPORT OF E. W. GUDGER, TREASURER, 1914-1915.
APRIL 23, 1915

RECEIPTS

Balance last audit	$ 186.06
Dues since last audit	67.00
Interest Savings Bank	4.46
Total Receipts	257.52
Less Expenses	96.55
Balance	160.97

RESOURCES

Savings Bank Balance	$ 114.47
Checking Bank balance	46.50
Total	160.97
Dues unpaid (about)	25.00
Stamped envelopes (about)	7.00
Estimated Resources	192.97
Estimated Debts	95.00
Estimated Balance	97.97

EXPENSES

Proceedings, 1914	$ 75.00
Secretary's expenses, Durham	4.90
Postage	5.50
Typewriting and clerical help	2.40
Printing	8.75
Total Expenses	96.55

OUTSTANDING DEBTS

Proceedings, 1915	$ 75.00
Printing	5.00
Miscellaneous (about)	15.00
Total (about)	95.00

The Treasurer next drew attention to a comparative financial statement synopsized on the blackboard showing the receipts, expenditures, and balances since 1907-08, and making it clear that our yearly receipts do not meet our yearly expenses, and that the deficit has had to be met annually out of our gradually diminishing savings bank account. Considerable discussion was then entered into on the question of raising the dues. This course, however, was deemed unwise and it was thought best to institute a vigorous campaign for new members that the income from initiation fees might swell the cash receipts at the same time that new blood was infused into the Academy.

On motion, unanimously adopted, the President was empowered to appoint a committee composed of one or more members representing each locality where meetings are held, with two members for the State at large, whose duty it shall be to make every effort possible to increase the membership of the Academy. President Wolfe announced as the Committee for 1916: Chapel Hill, A. H. Patterson; Durham, E. T. Miller; Greensboro, Miss Gertrude Mendenhall; Guilford College, John S. Downing; Raleigh, C. S. Brimley and Z. P. Metcalf; Wake Forest College, John F. Lanneau; State at large, Franklin Sherman, Jr., and the Secretary, *ex officio.*

Reports of committees being next in order, the auditing committee reported the Treasurer's books, accounts and yearly statement to be correct. The nominating committee next reported and the following officers were elected for 1915-16:

President, A. S. Wheeler, Professor of Chemistry, University of North Carolina.

Vice-President, W. A. Withers, Professor of Chemistry, State Agricultural and Mechanical College.

Secretary-Treasurer, E. W. Gudger, Professor of Biology, State Normal College.

Additional Members Executive Committee: Z. P. Metcalf, Professor of Zoology and Entomology, State Agricultural and Mechanical College.

W. C. Coker, Professor of Botany, University of North Carolina.

E. T. Miller, Professor of Engineering, Trinity College.

The resolution committee presented the following report:

The North Carolina Academy of Science, assembled for its fourteenth annual session, finds itself under renewed obligations to President Poteat, Dean Brewer, and the Faculty of Wake Forest College for the considerate manner in which they have provided us with a meeting place, and the kindly and gracious manner in which the citizens of Wake Forest have entertained us in their homes.

The Academy feels itself the richer for having heard the scholarly address of President Wolfe, and the Academy, which already owes a great debt to its Secretary-Treasurer for the able manner in which he has conducted his office, feels itself again with greatly increased obligations on its hands.

Therefore be it resolved by the North Carolina Academy of Science, that President Poteat, Dean Brewer, the Faculty of Wake Forest College, the citizens of Wake Forest, President Wolfe and Secretary Gudger have combined to make this one of the most profitable meetings of this Academy.

The report of the legislative committee on ventilation was then called for and the committee then discharged from further duty.

At 10 o'clock the reading and discussion of papers was then resumed with some 25 members and visitors present. The session continued until all had been read when adjournment was had at 1:20 P. M. Of the 23 papers on the program only three were read by title.

The membership of the Academy at the present time is as follows (those present at this meeting being indicated by a *):

Allen, W. M.; Balcomb, E. E.; *Brimley, C. S.; Brimley, H. H.; Bruner, S. C.; Cain, William; *Carruth, F. E.; Clapp, S. C.; *Cobb, Collier; Cobb, Wm. B.; Coker, W. C.; Collett, R. W.; *Cunningham, Bert; Dixon, A. A.; Downing, J. S.; Edwards, C. W.; *Farmer, C. M.; *Field, R. H.; Fulton, H. R.; Geiser, S. W.; *George, W. C.; Gove, Anna M.; *Gudger, E. W.; Hammel, W. C. A.; Harding, W. T.; Herty, C. H.; *Hickerson, T. F.; Hobbs, A. Wilson; Hoffman, S. W.; Holmes, J. S.; Hutt, W. N.; Ives, J. D.; Kilgore, B. W.; *Lanneau, J. F.; Lay, George W.; *Leiby, R. W.; Lewis, R. H.; Lyon, Mary; McIver, Mrs. Chas. D.; MacNider, W. deB.; MacNider, G. M.; Markham, C. B.; Mendenhall, Gertrude, W.; *Metcalf, Z. P.; *Miller, E. T.; Mills, J. E.; Newman, C. L.; *Patterson, A. H.; Pegram, W. H.; *Plummer, J. K.; *Poteat, W. L.; Potwine, Elizabeth B.; Pratt, J. H.; Ragsdale, Virginia; Randolph, E. Oscar; Rankin, W. S.; Robinson, Mary; *Sherman, Franklin, Jr.; Shore, C. A.; Smith, J. E.; *Spencer, H.; Stiles, C. W.; Strong, Cora; *Totten, Henry R.; Venable, F. P.; *Wheeler, A. S.; Williams, L. F.; Wilson, H. V.; Wilson, R. N.; *Withers, W. A.; *Wolfe, J. J.

The following papers were presented:

DESMOTROPY

ALVIN S. WHEELER

The first case of keto-enol isomerism among the phenols of the naphthalene series was recently reported by Willsaetter and Wheeler. Juglone, a dyestuff in greenwalnut shells, yields on reduction 1, 4, 8-trihydroxynaphthalene, melting at 152°. After once being melted, it melts thereafter at 96°. Since this type of compounds is very sensitive to alkalies, weakly basic reagents as semicarbazine and phenylsemicarbazine were employed to detect the carbonyl group. The lower melting product was found to be the ketonic form. Some work, not yet published, on 1, 4, 5, 6-tetrahydroxynaphthalene reveals another case of this nature. Here however it has been impossible to separate the two forms, the compound melting at 154° responding readily to both enolic and ketonic reactions. Numerous isomerisation methods fail to reveal another form. The application of Knorr's ferric chloride method and Kurt Meyer's bromine method to approximate the relative amounts of the isomers present is not practicable to the above cases. Ferric chloride oxidizes the compounds to quinones while bromine enters the ring of either form.

THE H-H WATERWHEEL AND PUMP FOR FARM WATERWORKS

T. F. HICKERSON

The Hutchison-Hickerson Waterwheel and Pump, recently invented by R. B. Hutchison of Wilkinsburg, Pa., and T. F. Hickerson of Chapel Hill, N. C., is a discovery of a new application of the old principle of the overshot wheel in the design of a small easy running combination Wheel and Pump and Stand (made in the factory complete for installation) to utilize the flow and fall of small brooks as power for operating continuously a pump which pushes pure spring water to higher elevations.

The remarkable simplicity, adaptability, and reliability of this machine brings it in direct competition with Hydraulic Rams, all of whose defects seem to be met satisfactorily by the Wheel and Pump.

One dozen of these Wheels and Pumps have been introduced in North Carolina during the past year. Among these is one which delivers every day through a vertical height of 45 feet 500 gallons of spring water for a large farm home, where the power of the stream which operates the wheel is only 1-100 of a horse power.

ON LEIDY'S OURAMOEBA AND ITS OCCURRENCE AT GREENSBORO, N. C.

E. W. GUDGER

In the fall of 1914, considerable numbers of large and active Ouramœbas were found at Greensboro. The Amœbas themselves and the locality in which they were found were described. Their activities both in feeding and moving were discussed, and it was noted that there was no reversal of polarity, the tail-feather-like mass of fungous hyphæ always remaining posterior. The history of this interesting organism was then reviewed, and the conclusion arrived at that Ouramœba (tailed Amœba) is nothing but an ordinary Amœba which has ingested fungous spores which have germinated and formed a mass of mould hyphæ which projects from the posterior end of the animal. The full paper will be published shortly.

SOME IGNEOUS ROCKS OF MOUNT COLLIER

JOHN E. SMITH

Mount Collier is in Orange County, N. C.; about 5 miles west of Chapel Hill. It is typical of those igneous monadnocks of the eastern Piedmont, most of which rise to a common level about 200 feet above the peneplain. It was formerly much higher and of greater extent this is shown by the position of parts of the mountain that have been

separated from it by erosion, also by the fact that Ball Mountain, in Davidson and Rowan counties, of similar rock and structure has been cut by a river (Yadkin) which flows through it. That the upland level of the region is a peneplain is also proved by the presence of smooth, rounded quartz pebbles on this plain.

The mountain consists chiefly of dark rhyolite which made its way upward along the contact between the ancient crystalline schists north of it and the granite on the south. On each if its slopes flow structure has been observed in the weathered rock and in many places where it is fresh.

It is called Mount Collier in honor of Professor Collier Cobb who, in 1892, was the first to recognize its igneous origin. (Specimens and structure sections were used in presenting the paper.)

SOME OBSERVATIONS ON THE RED CEDAR

H. R. TOTTEN

Juniperus virginiana is our common cedar and is the only species of *Juniperus* that is at all abundant in North Carolina. *Juniperus communis,* the northern cedar, is known to occur in a few localities in the mountains. The male and female flowers of *Juniperus virginiana* are borne on separate trees. The time of flowering is dependent upon the climate and weather. The male trees begin blooming first and the return of cold weather may delay the female trees. In both the seasons 1914 and 1915 the male trees began blooming nearly six weeks before the female trees. The young "berry" is formed soon after pollination by the growth and fusion of the sporophylls about the ovule. Fertilization takes place about the middle of June. The seeds are matured in the first season. The species is very variable in color and habit of growth, varying in the neighborhood of Chapel Hill and Durham, in color from a glaucous to a deep green, and in form from an open spreading tree to a close spreading tree and to a narrow columnar tree.

SIGNIFICANCE OF GOSSYPOL IN THE COTTON PLANT

F. E. CARRUTH

Gossypol, $C_{15}H_{14}O_4$ (or possibly $C_{30}H_{34}O_{10}$) according to Marchlewski* appears to be a dihydric (ortho) phenol.

It occurs in peculiar glands, "resin glands," in all parts of the cotton plant. Its physiological significance is not clear. The change in color of the cotton flower on ageing is probably due to it.

It is a yellow substance, dissolving in H_2SO_4 with a red color and oxidizing easily in alkaline solution with a deep blue color. It is being studied in an endeavor to show that it is a respiration pigment

* J. Prakt. Chem. 1899, 60, p. 80.

or an anthocyanic substance, rather than an end-product of plant metabolism. An effort to elucidate its constitution is being made by the N. C. Experiment Station.

FLY-PARASITES AS A FACTOR IN CONTROLLING ARMY-WORM IN NORTH CAROLINA IN 1914

F. SHERMAN

The Army-worm (*Heliophila unipuncta*) was destructive in many localities in North Carolina in 1914, attacking millet, grasses and grains. Tachina-flies were abundant and laid eggs on the worms.

A lot of 534 army-worms was separated into groups according to number of eggs per worm, and rearings made. Worms without visible eggs matured less than 10 per cent of moths. Of worms with fly-eggs less than 1 per cent matured moths.

Highest development of flies was from worms with 3 parasitic eggs each (32.81 per cent), the rate consistently declining both below and above that point.

On all worms collected, the average was 2.44 fly-eggs per worm, close to the desired optimum. Outbreaks were of short duration and there was no widespread damage by any later broods.

A more detailed article covering this work will be found in Journal of Economic Entomology for April, 1915.

ON THE MYTH OF THE SHIP-HOLDER, THE ECHENEIS OR REMORA

E. W. GUDGER

A brief account was given of some of the data relating to this myth, which began about the time of Pliny the Elder and persisted until about 1660. The true explanation was given by Ekman in 1904 in his work on "dead water."

Material and data are being collected for a series of papers giving accounts of and explaining the myth, describing the use of the Remora as a living fish hook, and lastly giving as fully as possible the natural history of the fish—the matter of chief interest being the origin of the sucking disk.

THE SEXUALITY OF THE FILAMENT OF SPIROGYRA

BERT CUNNINGHAM

The general opinion as shown by Wood (1872), Wolle (1887), DeToni, Klebs (1896), Vines, Bennett and Murry, and Mottier (1904), is that the filaments contain cells of one sex. West (1904), basing his assertion upon Hassall (1845), states that cross conjugation is exceedingly rare in Conjugales.

The writer found a Spirogyra which follows the general description of Quadrata, with the exception of reproduction. This frequently occured as cross conjugation, the zygotes being in such a position that it could not possibly be a combination of lateral and scalariform conjugation.

This occurrence would tend to prove that the filaments of some Spirogyra at least are truly bisexual, and that the transition from the bisexual to the unisexual occurred in the family of Spirogyra.

ABNORMAL SPECIMENS OF TARAXACUM

S. W. GEISER

This paper notes the occurrence of a clump of dandelions at a point 70 feet e. n. e. of the n. e. corner of Cox Hall, on the Campus of Guilford College. Seven specimens showed well fasciation of the flower-stipes. The multiple-headed character was not so pronounced as noted by *Kirsch* (1909:) only two or three stipes in each of the specimens were united. The flower heads were either slightly confluent or independent. At the point of collection, the soil was unusually infertile, and the occurrence suggests *Nieuwland's* ('09) conclusion that the abnormality is due to a physiological change due to unfavorable soil conditions, and to age. *Bowditch* ('09) has also noted fasciation of the dandelion (*T. off.*) in an unfavorable environment. Diligent search failed to find abnormal specimens outside of the local circumscribed area.

For the following papers no abstracts have been received.

The Present Status of the Martian Controversy—A. H. Patterson.

Filose Phenomena in Pieces of Gonads of a Cubomedusa—H. V. Wilson.

More Fossil Plants from the Moncure Shales (32 specimens)—Collier Cbob.

Cow Pea Weevil—Z. P. Metcalf.

Gossypol, the Toxic Substance of Cottonseed Meal—W. A. Withers and F. E. Carruth.

The Influence of Salt Solution on the Development of the Frog Egg—W. C. George.

Experimental Alteration in the Direction of Growth of a Sponge—H. V. Wilson.

The Importance of Humidity in Health and the Arts (with demonstration of a new form of Humidifier of North Carolina make)—A. H. Patterson.

Simplifying our Methods of Teaching Cell Division—Z. P. Metcalf.

Monadnocks and Metamorphism in the Cretaceous Peneplain—Collier Cobb.

The Origin of the do, re, mi Syllables for the Musical Scale.—A. H. Patterson.

Notes of Geology of Smith's Island—Collier Cobb.

E. W. GUDGER, *Secretary.*

AN OUTLINE OF MODERN WORK BEARING ON THE THEORY OF DESCENT

BY J. J. WOLFE

In my eagerness to select a subject worthy of presentation on this occasion, I have, like many another, attempted a task much bigger than I had realized. It is apparent that nothing approaching encyclopædic treatment is possible. You will, therefore, find much important work conspicuous by its absence. I do, however, regard the generalizations and experiments discussed as being, in the main, those most pertinent to the matter in hand.

You can hardly be better persuaded than I am, that it is hazardous in the extreme to attempt to speak at the present time with any degree of positiveness concerning the subsidiary theories involved. Wide differences exist in the minds of equally able students both as to the value and the interpretation to be put upon recent and current work. The subject, however, is so vital, and so grips the attention wherever we meet it, that it seems to me well worth while to review this work even if it must be in a most tentative fashion.

MENDEL'S LAW

We may begin this review with the opening of the present century. Until this time the theory of descent was in its essentials just as Darwin had left it in 1859. The year 1900, however, is made memorable by the rediscovery of the unpretentious studies of an Austrian monk, Johann Gregor Mendel. His results were published in 1866 in an obscure journal where they lay buried until unearthed independently and almost simultaneously by three distinguished botanists, Dr. Vries of Holland, Tschermak of Austria and Correns of Germany. Mendel was a student of Carl Nageli, another great botanist, to whom he sent his results, but somehow the master failed to grasp the significance of his old pupil's work.

Mendel's method differed from that of earlier students of heredity in that he focused his attention upon the behavior of a *single* pair of alternative characters. He selected the ordinary garden pea to work with, and for eight years carried on his experiments in hybridization. The parental characters reappear in their hybrid offspring in a perfectly definite fashion, which has come to be known as "Mendel's Law."

An example or two may make this clear. A tall pea, crossed with a dwarf, produces offspring which are invariably tall. So it is when round seeded pears are crossed with wrinkled ones, yellow with green and with a host of other character-pairs which have been tested by Mendel and his followers. The offspring are not intermediate in character between the two parents as had been universally supposed to be the case, but wholly like one parent which Mendel called the dominant. The character which does not appear in the offspring—dwarfness in this case—is called recessive.

Now when these hybrids are interbred, three kinds of offspring are produced and, when the numbers are large, in fairly definite proportions. One fourth are dwarfs and breed true. The remaining three-fourths are tall, and look alike, but behave differently in reproduction. One of the fourths is tall and breeds true, the other two-fourths are tall, but not true breeding—they split up again in the same ratio —25 per cent true breeding tall, 25 per cent true breeding dwarfs, and 50 per cent tall but not breeding true, and repeating this behavior in the next generation.

Another case—the blue Andalusian fowl does not breed true. Its offspring is 25 per cent white, 25 per cent black and 50 per cent blue. The whites and the blacks breed true to color, but the blues repeat the story. The Andalusian is thus seen to be not a true race of fowls but merely a hybrid between a white and a black race, in which black is not entirely dominant as it is in guinea pigs for example, and as it usually is, and as tallness is to dwarfness in the case of garden peas.

Similar experiments have been carried out involving two and even three pairs of such characters, but the combinations become too complex for presentation without figures. Suffice it to say that with but few exceptions any pair of characters will behave as above described.

Cases such as those cited show that a character may be extracted in a pure state from a hybrid even when it is completely masked by a dominant. Characters must therefore be represented in the germ cells by independent units that never lose their identity.

Mendelism thus puts in the hands of the experimentalists a definite standard of measurements by means of which he may test the hereditary constitution of living organisms, and to the practical breeder its gives a definite formula in accordance with which he may purge a chosen race of undesirable characters and even supplant them with desirable ones extracted from many sources, with somewhat the same exactness that a chemist extracts and combines his chemicals.

THE PURE LINE

Before great progress can be made in any science, the fundamental units which enter into its facts must be clearly understood. "Chemistry was alchemy until the chemical elements were identified and isolated." Similar fundamental units in heredity are the Mendelian unit characters, and we now speak of heredity in terms of unit characters rather than of the individual as a whole.

A species as the term is today coming to be understood consists of subsidiary groups of individuals, which groups differ from each other in average size, structure, color and other unit characters, which in heredity, according to Jennings, behave "as rigid as iron." The progeny of individuals belonging to one such group constitutes the so-called "pure line." This conception rests upon the brilliant and independent investigations of the Danish botanist Johanssen, the American zoologist, Jennings, head of his department at the Johns Hopkins University, and the Swedish botanist Nilsson.

Johanssen, to cite the work of but one of them, experimenting with beans, isolated nineteen such groups of pure lines, " . . . . the progeny of each of these pure lines of beans varied around its own mean, which was different in each of the nineteen instances." It matters not whether the smallest or the largest individuals are chosen to breed from, the progeny in either case is the same, which is the average for the pure line in question. The conclusion then is that "Selection within a pure line is absolutely without effect in modifying a particular character in the offspring of the line in question." Nor can selection from the mixture of pure lines which constitute the species accomplish more. The utmost that it can do is to isolate that pure line which exhibits the character in question developed to the highest degree. Manifestly this is a discovery of far-reaching significance, for if these things be so, how can the transition from one pure line to another have been made? That such transitions have repeatedly occurred is, it would seem, beyond intelligent question, but how, looms larger today than ever before. There seem to be but two answers now made to this question: one of these is mutation, which makes the passage from one pure line to another at a single bound, but which seems to me much too questionable a support for any great super-structure; the other is the inheritance of acquired characters, an ancient dogma but not now in good standing in most approved scientific circles. Later on I shall discuss each of these theories at some length, but now before leaving this topic it should be added that Johanssen has recently reported mutations within his pure lines. This is, however, as Walter has pointed out, a clear case of the logician's "vicious circle." For so long as a variation does not reappear in the progeny it is taken to prove that such variations are individual, due to effects of the environment, and not heritable, but, whenever such variations do reappear, they are at once styled mutations.

DARWINISM

With your indulgence, I will now sketch in as briefly as

I may the background of Darwinism upon which mutation may be most effectively projected. Darwin, as you well know, based his theory of the origin of species upon the minute variations presented by all living things. There are no two human beings, no two trees, no two flowers, in fact no two living things of any kind exactly alike. Nevertheless, organisms continue to produce offspring which in the main resemble their parents. The developing plant or animal behaves as if it were acted upon by two opposing forces, one heredity, a centripetal force tending to hold it down to type, the other variation, a centrifugal force tending to throw it off at a tangent. These variations occur in all directions, some of advantage to their possessors, some possibly without effect, others positively detrimental.

Couple with this the further fact that vastly more plants and animals are produced than can possibly find room and food for development. It is difficult to conceive the prodigious members of every species that would exist were it not for checks put upon them by the environment. The conger-eel it is said lays 15,000,000 eggs. If these all reached maturity it has been computed that in less than ten years, the waters of the globe would be solidly full of conger-eels, all the progeny of a single pair. "Even slow-breeding man," says Darwin, "has doubled in 25 years." "At this rate in less than a thousand years there would literally not be standing room for his progeny." In the keen competition that must thus necessarily ensue in a state of nature the great majority of these are doomed to early destruction. Manifestly it is the best endowed, the fittest in Darwin's phrase who survive. For this process Darwin coined the term *natural selection* and looked upon it as the controlling principle in shaping the course of evolution. It operated on those minute variations already referred to, weeding out those individuals which did not vary in directions tending to adapt the organism more perfectly to its environment. The summation of these favorable variations in the course of time would be suffi-

cient to warrant classifying the form as a species distinct from the parent type.

From the flood of criticism that fell upon the "origin" two ideas may be singled out for consideration. First is the view that imperceptibly small variations in the direction of producing a new structure could be of no possible service and therefore would have no selection-value. Second, that geologic time is too short for the evolution of the complex living forms that we know out of simple undifferentiated organisms. Without entering into a discussion of these objections, suffice it to say that their weight was felt to be great by many Darwinians. To such, and many others, the mutation theory was most welcome.

MUTATION

It was ably presented to you at the Wake Forest meeting five years ago by President Poteat. I shall therefore at this time attempt only a brief outline. The mutation theory is the great life-work of Hugo De Vries of Holland already referred to in connection with the rediscovery of Mendel's results. Appearing in 1901 it embodied the extensive experimentation of the preceding twenty years. As a basis for the operation of natural selection, De Vries takes the more striking variations, the previously called "sports" to which he gave the name—mutants—such for example as the sudden appearance of a rose-comb in an apparently pure bred race of single comb fowls, or a white English sparrow, several times recently reported in "Science," and which I observed some months ago on the streets of Durham. Darwin was familiar with this phenomenon and cited numerous cases in his "Animals and Plants under Domestication," but after mature deliberation and after it had been urged upon him by some of his closest scientific friends, he reached the conclusion that "sports" were without important effect on the origin of species—an opinion it would now seem destined to receive recruits.

These sports or mutants breed true from the beginning and thus furnish a foundation for the view that new species

are produced, not as Darwin thought by the gradual accumulation of minute differences, but all at once by the sudden appearance of full fledged new characters which sharply distinguish them from the parent species.

The theory certainly leaped into favor. It effectively disposes of the criticisms of Darwin's theory to which I have referred. Furthermore, mutations instead of being extremely rare phenomena are almost becoming common. This is due it would seem to the fact that mutationists are coming to lay less emphasis upon the magnitude of a mutation and more upon its heritability. Many of the departures that now pass as mutations could I think very well be included under Darwin's variations. To claim heritability as a criterion between mutations and Darwinian variations as seems now to be the tendency would, in my judgment, rob Darwinism of all claim that it has to bring an explanation of evolution, since it leaves it in the absurd position of being based on non-heritable variations.

CRITICISM OF MUTATION

For some years now there has been a growing suspicion that the phenomena of mutation are really due to hybridization. The English geneticist, Bateson, seems to have been first to suggest that Lamarck's evening primrose, upon which De Vries primarily based his theory, is in reality a hybrid. Much evidence has now accumulated to sustain this view.

Davis, Professor of Botany at Pennsylvania, has attempted by hybridization to produce a complex type which in reproduction will behave like *Oenothera Lamarckiana*. He has apparently succeeded in producing fairly constant hybrid races which occasionally throw off mutants much as does the classic example. Similar results have likewise been obtained by Tower working with potato beetles.

But in my judgment the most significant attack upon mutation has been made by Jeffrey, of the Harvard Botanical laboratory. Jeffrey investigated the evening primroses with a view to determining the amount of sterility present. It has long been known that infertility was characteristic of

hybrids, and curiously enough this fact was invoked as long ago as 1837 in support of the view that the sperm was really essential to the act of fertilization. In that year R. Wagner showed that sperms were invariably absent in non-fertile hybrids and as invariably present in all fertile males. Jeffrey found that without exception a high degree of sterility was characteristic of every species examined. Furthermore all known hybrid plants available were examined with essentially the same result. On the other hand an extensive investigation, ranging from the highest to the lowest plants and including a large number of species as to whose genetic purity no suspicions are entertained, revealed absolutely no sterile pollen whatever. Since in this respect the evening primroses ally themselves with undoubted or suspected hybrids Jeffrey maintains that the group as a whole is much contaminated by hybridization and that no such important theory as mutation should rest upon so dubious a foundation. De Vries has recently replied at considerable length to Jeffrey's attack but without, in my judgment, seriously damaging the criticism.

Among other things, he cites cases of mutation in the common shepherd's purse and asserts that its pollen is all perfect. This, however, is manifestly an error. I have just begun an examination of this plant myself and there is abortive pollen here, just as Jeffrey found in all his hybrids.

Since the connection between sterility and hybridization has been so long and so well known, it would seem strange that its significance should have escaped De Vries, who was aware of the fact that sterility was more or less abundant in his primroses. In the controversy which is still going on, it appears that De Vries is inclined to admit the contention of Davis, Tower, Jeffrey and others that mutants may arise as a result of hybridization, but still clings, with other mutationists, to the view that mutation is a distinct phenomenon in no way dependent on hybridization.

To be sure there are numbers of cases where mutants or sports have appeared in which it is very difficult to impugn

the purity of the strain, nevertheless in the present state of our knowledge it would seem wiser to account for them as a result of hybridization far back in the line, than as the production of an entirely new character by the operation of some as yet wholly unknown force.

While this would seem to be true it is possible that it does not apply to all cases. De Vries divides his mutants into two classes, one characterized by the appearance of a character wholly new, and the other by the loss of some character previously possessed. This latter, it would seem, might and probably does occur with the intervention of hybridization. It is a matter of common knowledge that accidents happen during the embryonic history of the individual which prevent the development of organs and tissues and, to me at any rate, it is no more difficult to think that certain conditions might, even in the germ cells, destroy, some one of these units of living matter which would otherwise in the mature animal express itself as a character. For example, albinos are simply animals in which for some reason or other the color factor has failed to express itself. Granting this, however, the tendency of present investigation is to rob mutation of any really great significance in the hypothesis of descent and perhaps throw us back either to Darwin or Lamarck.

ACQUIRED CHARACTERS

Whether acquired characters are inherited or not constitutes for biologists a seemingly eternal question. Are diseases, mutilations, habits, the effects of use and disuse handed on to offspring—these are some of the forms in which the query has been put. But from whatever angle the problem be approached the real aim has been to find whether or not the environment can in any way reach and impress itself upon the germinal substance so that its effects may be transmitted. That such is the case was generally believed a hundred years ago and the idea was made the foundation of the theory of evolution propounded at that time by the celebrated French biologist Lamarck.

There are some more or less well known practices which incidentally seem to support this hypothesis—for example the growing of bacteria under adverse conditions such as excessive heat with a view to reducing their virulence. Certain disease-producing forms so treated may then be safely injected into the human being, whereas before such treatment it would have resulted fatally. Southern market gardeners pretty generally purchase northern grown seed where early crops are desired. The explanation is that short northern growing season somehow speeds up the life processes so that the cycle is complete before cold weather. Seed from plants so grown are supposed to inherit this rapid maturity.

Tower, a zoologist of Chicago University, in his experiments with potato beetles found that species carried from Chicago were so altered by a stay at Tucson, Arizona, under desert conditions that when carried back to Chicago some years later they were unable to withstand the winter. According to Tower no selection is practized and this condition is gradually brought about.

Bordage, a botanist of Reunion, a French island off the coast of Madagascar, reports that European peaches carried to Reunion retain their deciduous habit permanently at higher altitudes, but in the coastal region the leafless period is gradually shortened until after 20 years they are completely evergreen. Seedlings of such trees show the acquired character to the same extent as the parent tree, but no more. Furthermore they retain this character even to the second generation in higher altitudes where trees that have not been so modified shed their leaves every autumn.

Besides such cases there have been many experiments devised primarily to prove this proposition. Bonnier, a member of the French Academy of Sciences, published in 1895 an extensive series of experiments. In all he handled 105 species. Plants growing in the lowlands were transplanted to alpine conditions. In a few years these had acquired the aspect of the characteristic alpine species of the same genus even to cell and tissue structure. When carried back to the

lowlands, plants that had grown at elevated locations for four to six years retained their alpine characters for four to six years, but eventually returned to the habit and character of lowland types.

The well known German botanist, Klebs, likewise experimented extensively in this line with the net result that many acquired characters are inherited while others are not. Perhaps experiment should now be directed toward ascertaining just what acquired characters are inherited.

Lest you should imagine that I have ignored the evidence from the zoological side let me briefly refer to Kammerer's results. It should be added, however, that zoologists are more nearly a unit than botanists in the view that acquired characters are *not* inherited.

Kammerer at Vienna by reducing the amount of water succeeded in permanently modifying aquatic species of salamanders so that they came more nearly to resemble land forms and by changing the color of the soil on the bottom of the aquaria transformed the color of the animals so as to correspond very nearly with the color of the substratum. These effects according to Kammerer are hereditary. There are numerous other experiments of this kind made on animals with corresponding results, still it must be said that the bulk of the evidence furnished by experiments on animals seems to support the negative side of this proposition. Unfortunately, however, this is not a question that can be settled by majorities in the good old democratic way.

Castle, of the Harvard Zoological Department, as well as several others, has made some beautiful experiments in the hope of solving the problem. Their method consists in grafting the ovary of one animal into another from which her own had been removed. The body of the animal operated upon may be looked upon as a new environment for the engrafted ovary, and by reason of the intimate relations existing ought to exercise a marked influence in heredity, if such a thing be possible.

The details of one of these experiments is as follows:

The ovary is removed from a young female, white in color, and that from a black animal substituted. The animal operated upon is then mated with a male pure white in color. All the offspring were absolutely black. The black ovary although transplanted to a white animal produced young which were colored exactly the same as would have been the case had the ovary remained in the body of the black animal from which it was taken. This is in accord with Mendelian principles—black dominating white. In other words the body tissues of the foster-mother had no effect whatever, upon the color of the developing embryo. Castle, as well as others, has regarded such experiments as lending great support to the view that the environment produces no heritable effects. The lifework of August Weisman, the great German biologist and philosopher, who died last fall, was in a sense a continuous and formidable onslaught upon Lamarck's hypothesis. Weisman founded his attack upon the fact that the germ substance is very generally early set apart in the development of each animal from egg to adult. Once so set apart, he contended, the germ cells could not be influenced by the tissue cells, a thing must happen if a character impressed upon the body cells is to become hereditary. This has now become to be pretty generally the dominant view with geneticists and embryologists. The Weismannian contention, however, is not so formidable as it once seemed. It is a well known fact that the germ cells exercise a profound influence on the body cells. Is it too wild a flight to suppose that there might be a reverse influence? At any rate such a view becomes somewhat more tenable in the light of recent researches on the ductless glands, which have their effect in distant parts of the body by means of substances secreted into the blood. These substances are called harmones, and it is coming to believed that they are of very general occurrence and very great importance.

The fact upon which Weisman based his criticisms seems to me to furnish a basis for the more or less evident line of cleavage between zoologists and botanists on this question.

The germ-plasm is early set apart in animals, but this is not so in plants which develop new germ tissues each season. Also it would seem more difficult for the environmental influences to penetrate the thicker envelope of body tissues in animals,and to produce effects upon cells in more or less constant environment. The body fluids surrounding these cells and which constitute their environment are artificially maintained at fairly uniform pressure, temperature, composition, and concentration. For these reasons it would seem to be much easier for environmental factors such as temperature, moisture, and light, to act upon the germ tissues of plants than of animals. However this may be, it is much more than probable that any generalization such as the inheritance of acquired characters if found to be true for plants would also be true for animals, although it is easily conceivable that special animal characteristics might render the operation more difficult of observation.

Such a view appears at least to be near the truth. The inheritance of environmental effects in some fashion has long seemed to me a logical necessity. To assume that they are not, would force the conclusion that *all* heritable variations are represented in the germ-plasm, and, to carry the thing to its ultimate end, there were bundled up in the first organism all the infinity of possibilities that have since appeared in living things. Darwin, in his later writings, felt that the environment in some way acted upon the germ cells so as to call forth variation, but the cause of most variation was so dark that he frequently referred to its as spontaneous. I take it, however, that at the present time no scientific man will undertake to maintain spontaneity of any kind and by the word merely means that the cause is unknown.

Therefore, so far as I can see, we are shut up to one or the other of these conclusions, either new characters, which can be transmitted and summed up in heredity, are called forth by the environment, or all past, present, and future variations were present in that primordial germ cell and subsequent variation has been a process of release by the drop-

ping out of something which inhibited the appearance of these characters so long as it was present. This is just the view proposed by William Bateson in his presidential address to the British Association for the Advancement of Science last summer at its meeting in Australia.

Certainly this is not a very satisfying theory, still it is not altogether unthinkable as the philosophers have a fondness for saying. At any rate we have at least one striking analogy —the mature man develops from a fertilized egg so small that it is scarcely visible to the unaided eye; nevertheless, there are collected within this small scope representive units, which we call determiners, for every important physical, mental and moral trait that constitutes the fully developed man.

CONCLUSION

The hypothesis of descent is thus in a somewhat unsatisfactory state. The newer researches have made old views untenable without in themselves furnishing a complete explanation. Such periods, however, are not infrequent in the history of science. At the present time, there is little that can be asserted with any degree of positiveness beyond the fact that somehow or other evolution has occurred. This central fact has been strengthened with the passage of the years, although as regards just what has taken place, how, and by what means, they have left us pretty much as we were in 1859 after the appearance of Darwin's "Origin."

These years of research have been wonderfully effective in untangling the factors in a most complex problem and the reason why success has not been completely attained seems to me to lie principally in the fact that the problem was more complex than the workers have, hitherto, realized. With the experimental method added to the equipment of the investigator, which, in my judgment has been hitherto limited too much to the microscope, and with the concise results of Mendelism, mutation and pure line investigation, it seems to me not extravagant to expect a comprehensive explanation of the problem at a date not very far distant.

And now, before I conclude, let me add that it with much pride that I note the brilliant part taken by Americans in this line of investigation, and that, if the past be any guarantee of the future, I predict they will have a far greater share in its final solution.

And also, in conclusion, perhaps I should explain that, if in the rather frequent use of the first person it seem to you I have attached undue importance to my own views, this form of expression has been often assumed for the sake of brevity, but more especially to indicate that an opinion was being expressed which could not be said to have won its way to anything like an universal acceptance.

DURHAM, N. C.

RADIO-ACTIVITY AND THE PERIODIC SYSTEM*

The periodic system of the elements has for nearly half a century proved a most puzzling and absorbing problem to chemists. It has been called a law, but while there is undoubtedly an underlying law or laws, I doubt whether we have as yet any very clear conception of them. Certainly, the usual statement that the properties of the elements are periodic functions of their atomic weights was never strictly true, even in days of partial knowledge, and is much less true now. It was neither the periodicity "of the geometers," as Mendeleeff himself said, nor the function of the mathematician. Indeed, we have now come to a view where, apparently, we must abandon the atomic weight as the only or even the chief determining variable.

The truth is that for many years after its announcement it was more truly a working hypothesis, and a great deal of work had to be and still has to be done before it can attain to its completed form. It contains much that is true, has been most useful as a guiding principle, and has shown a wonderful power of adjustment to new facts and increasing knowledge.

It was in 1895 that the system had to adjust itself to the first severe jolt which it received through the discovery of argon and helium, and three years later, of other inactive, monatomic elements. The necessity for readjustment here had been in part foreseen. The abrupt change in the progression of the elements from strongly electro-negative fluorine to strongly electro-positive sodium, and, in general, the transition *per saltum* from period to period had been discussed by Reynolds and others. It needed explanation and was impossible mathematically except by passing through zero or infinity. Some, as Sedgwick and de Boisbaudran, seem to have predicted such transition elements, and when argon was discovered it was not difficult for Julius Thomsen

* Reprinted from *Science*, N. S., Vol. XLI, p. 589, 1915. Read before the Elisha Mitchell Scientific Society, March 9, 1915.

and de Boisbaudran to arrange an entire zero group with approximate atomic weights three years before Ramsay's brilliant discovery of the other inactive gases.

There are other anomalies in the system which are difficult to explain with the accepted tabulation. Such, for instance, is the existence of the rare earths, now some sixteen in number, so closely alike chemically and so different from other chemical individuals. The more they are studied, the less possible does it seem to fit them in any vacant places in the table. Meyer has recently suggested that they may form a miniature periodic system in themselves reproducing the relations of the main system. But a more serious breakdown in the supposed fundamental principle of the system comes in the relative position of such elements as argon and potassium, cobalt and nickel, tellurium and iodine. After most exhaustive investigation of their atomic weights it has become evident that these can not be used in deciding the relative order and at the same time have these elements fall into the proper grouping with those elements chemically most nearly related to them. So the order of the atomic weights has been tacitly abandoned and the superior determining power of the chemical characteristics acknowledged. This can only mean that the mass of the atom is not the sole, nor indeed the chief, determining variable, and it would seem that the search for the latter can only be ended by the solution of the problem as to the nature of the atom itself.

Certain clews to this have undoubtedly been in our hands for a long time, but their leading was not clear and the thought of them baffling. Such, for instance, were the facts that by taking an atom of nitrogen and four of hydrogen a grouping of atoms was obtained which behaved in general as an atom and was the analogue of potassium. Or, again, carbon and nitrogen give us an analogue of chlorine—and so with compound radicals in general. But while both building and tearing down again were easy, they seemed to throw no light on how those we could not tear down were once built up.

Still another thought-inspiring fact which would seem to have important bearing on the nature of the atom and hence the meaning of the periodic system is the ease with which certain elements by a change of valence change their chemical character and form distinctive series of salts as if they had been transformed into different elements. This causes some confusion and what would ordinarily be called forcing in the present tabulation of the system, and it will be recalled that Mendeleeff, in his earlier tables, actually placed certain of the metals, as copper and mercury, in two different groups, assigning each two different places. Signs are seen in the work of Barbieri and others of a tendency to place certain of the elements in different groups according to valence.

I believe that one should keep in mind the idea involved in Patterson-Muir's definition of an element as a collection or group of properties. Thus there are weight, electro-chemical nature, affinity, valence and other properties by which we recognize it and differentiate it from other elements and to which our knowledge of it is necessarily limited. There is a more or less definite gradation in these properties from element to element, showing an inter-relationship, and yet scarcely in itself justifying the conclusion that any one property determines the others or that they are dependent upon it. While it is true that it is hardly possible to dissociate these properties from some conception of matter, such conception has not yet reached its ultimate analysis and until it has we are dealing with the recognized properties alone.

In the same year in which the periodic system was forced to adjust itself to a zero group another discovery was entering upon its marvellous development which was to open up new views as to the nature of matter and radically affect the system. The remarkable and illuminating results obtained in the study of radio-active substances are paving the way for an understanding of the laws on which this system is based.

Radio-activity was regarded by Mme. Curie as an atomic property and this was the guiding thread which led to the discovery of radium. Of course, this preceded by a number

of years Rutherford's announcement of his theory of successive transformation or the disintegration of the atom. It is a question whether the fact that an atom is undergoing disintegration is to be regarded as a property in the same sense as the mass, valence, etc., but so long as this change can not be induced, changed or stopped and is known to take place only in the case of a fraction of the elements it is certainly distinctive and may be called a property for lack of a better name. There is, however, undoubtedly a cause for this disintegration and this instability may be due to some inherent property of the atom.

At present there are some thirty-seven radio-active bodies known, with the possibility of still others being identified. Each has distinctive radio-active properties. For a number of these the chemical and physical properties are known. Each is an atom hitherto unknown and must be considered a new element. Of course, the present accepted arrangement of the periodic system does not provide for so many additional elements and indeed is rather hopeless for even the sixteen rare earth elements. What is to be done with this embarrassment of riches?

Soddy's study of the grouping in well-known families of a number of the better known radio-active elements according to their chemical properties, combined with a consideration of the kind of disintegration by which it was produced led him to a generalization which would enable one to place correctly any radio-active element whose source was known, and at the same time give an approximation as to its atomic weight.

Fajans arrived at the same generalization independently from an examination of the electro-chemical evidence, finding that the product of an α ray change was more electro-positive, while that of a β ray change was more electro-negative. Similar conclusions from various evidence were reached by Fleck and Russell.

The generalization is as follows:

When an α particle is expelled it carries with it two atomic charges

of positive electricity and the expulsion of these two positive charges from the atom affects the valency of the product, as Fajans has pointed out, just as in ordinary electro-chemical changes of valency. If the atom were initially in Group IV., for example, its ion is tetravalent and carries four atomic charges of positive electricity. Two such charges having been expelled with the α particle, the product is in the di-valent Group II., non-separable from radium. The mass in this case is four units less. So with the β ray change. The β particle is a negative electron and the loss of this single atomic charge of negative electricity increases the positive valency of the product by one. Radium B, for example (in Group IV.), expels a β particle and becomes radium C (in Group V.). Whenever two or more radio-elements fall in the same place in the Periodic Table, then, independently of all considerations as to the atomic mass, the nature of the parent element, and the sequence of changes in which they result, the elements in question are chemically non-separable and identical. As will later appear, this identity extends also to most of the physical properties such as volatility and spectrum reactions.*

To express this "newly revealed complexity of matter," Soddy has suggested the word isotope. A group of two or more elements occupying the same place in the periodic table, differing in atomic weight yet chemically non-separable, is isotopic. There are possibly seven such elements isotopic with lead. Radium is one of four isotopes. The chemistry of thirty-seven radio-elements is thus reduced to a smaller number of about ten types.

Two fundamental changes in the old views as to the system are indicated here. First, the position of an element is not fixed but can be changed in either of two ways—by a change in valence (which, as is well known, can be brought about in various ways), and again by disintegration due to ray-emission. Secondly, more than one element can occupy a given position in the system. This is independent of the atomic weight, but such elements are chemically inseparable. This involves the giving up of all idea of the properties being functious of the atomic weights and necessitates the formulation of the law anew.

The place occupied by an atom is not solely determined

* Soddy, "The Radio-active Elements and the Periodic Law."

by its mass but by its electrical content as well. According to Soddy, the system represents the chemical character of matter as the function of two variables instead of one. The electrical content is the essential variable in horizontal columns and mass is the essential in vertical columns.

It is somewhat early to raise the question as to whether all elemental atoms are the result of disintegration processes, or, conversely, of synthesis, but in any case the old puzzle remains as to their great irregularity in weight relations if the most accurate chemical determinations are to be relied upon. If the time should arrive when they could be calculated, chemists would naturally return to hydrogen as the standard. Certainly, at present these weights present no simple synthetic relations.

An explanation of this is perhaps at hand if the view of Soddy (and of Crookes at an earlier period and from a different standpoint) is accepted, namely, that in atomic weight determinations it is not a natural constant that is gotten but a mean value of non-homogeneous masses. In other words, the weight may represent the average of various isotopic atoms and not the absolute weight of identical atoms.

It is very fortunate that the simple expedient of arranging the elements in the order of their atomic weights could give the early workers so nearly correct a view of the periodic system. It would probably have remained hidden for a long time if this had not been so prominent a factor in determining the proper sequence. There is undoubtedly a proper sequence. This has been settled hitherto chiefly by consideration of the atomic weight, but also by examination into the relationship existing between the elements. For instance, the order of atomic weights would be iodine and then tellurium, but chemically tellurium belongs to Group VI and iodine to Group VII. Therefore, the atomic weight order is reversed.

The sequence numbers of the elements, or atomic numbers as they are called, assume a new practical and theoretical importance. Within twenty years after the announcement of the periodic system, some, as Fedaroff, had sought to attach

importance to these numbers, but the efforts had little to commend them. Lately it has been suggested by van den Broek that this is a fundamental and important number. Beginning with 1 for H, the numbers would be 2 for He, 3 for Li, 4 for Be, etc. The question then naturally arises, can these numbers be reliably determined without reference to the atomic weights and correcting the manifest mistakes made in following the simple order of these weights?

One method for doing so, though with limitations, lies in the measuring of the scattering of the α particles when passing through different kinds of matter. Geiger found that the angle of the scattering seemed to depend very largely upon the atomic weight of the scattering metal. A very small fraction are scattered through such a large angle that they return on the side of incidence. This deflection is, of course, both a volume and surface effect. For equal thickness of screen calculations based on Rutherford's conception of the atom and his belief that this large angle scattering is due to the near approach of the positively charged α particle to the positive nucleus of the atom of the screen would make the scattering vary as the product of the density by the atomic weight. Thus Rutherford calculated that the scattering by gold should be about fifty times that by aluminium. This has been confirmed by the experiments of Geiger and Marsden, and the relative scattering has been determined for a large number of elements. The phenomenon is manifestly one determined by the electrical content of the atom.

The nuclear charge of the Rutherford atom can be calculated from the α particle scattering at various angles. This charge is found to be one-half the atomic weight multiplied by the charge of an electron. The same value was reached by Barkla by observations on X-rays. Soddy concludes that it is the nuclear charge rather than the atomic mass which fixes the position of the element, basing his conclusion largely upon the work of Barkla, Sadler and Moseley, which will be briefly outlined further on. This in reality agrees with the hypothesis of van den Broek that the number of electrons in

an atom in the neutral state determines the place of the element if hydrogen has one electron and one nuclear unit charge, helium two electrons and two nuclear unit charges, etc.

The direct method then is a combination of the work of Bragg, Barkla and Sadler, and Moseley. Making use of the work of those first mentioned, Moseley photographed the spectra obtained by the cathode-ray bombardment of a number of elements, the X-rays thus produced being reflected and defined from a crystal face. The frequencies of the vibrations could be determined and this frequency was found proportional to the square of the atomic number. That is, there was a definite shifting in the direction of shorter wave-length in the spectrum of an element from that of the one next above it in the list.

The graphic representation of the system has never been satisfactory in spite of the many efforts to solve it. It is especially difficult to bring out the facts by any representation on a plane surface. The faults of the Mendeleeff table can readily be seen, and they make it very desirable to secure a better mode of expression. And yet it is difficult to use the three dimensions of space so that the average student can grasp the whole. Soddy's lemniscate curve certainly has its good points. This may be compared with the arrangement of Rydberg. It can not be claimed yet, however, that the law or laws underlying this system are known and well understood, and until such time a complete and satisfactory graphic representation is scarcely to be expected. We can agree at least that progress is being made toward such an understanding.

CHAPEL HILL, N. C.

A LIST OF HOMOPTERA OF NORTH CAROLINA

BY Z. P. METCALF

The present list is not complete in any sense of the word but simply represents our present knowledge of the species of Homoptera which have been collected in this State. The two sources of our knowledge of the Homoptera of the State have been the published writings of the American Hemipterists Uhler, Osborn, Van Duzee and Ball and the collections made in the State. The largest collection of Homoptera in the State is that of the State Department of Agriculture which owes its inception and growth to the enthusiasm of the chief of the Division of Entomology, Mr. Franklin Sherman, Jr. The large number of times the initials F. S. occur after locality data will show clearly that Mr. Sherman has collected these small insects assiduously in practically all parts of the State. This collection was also enriched by the addition of numerous specimens collected in a trip during the month of September, 1909, when the writer collected at Blowing Rock, Yonahlossee Road, Grandfather Mountain, Balsam, Waynesville and Montreat.

The collection of the Division of Zoology and Entomology of the College of Agriculture contains a good series of most of the species that have been taken at Raleigh together with others which have been acquired by purchase.

The collection of Mr. A. H. Manee made at Southern Pines is rich, especially in those forms that occur further South.

In nearly all cases individual localities are given as our collecting has not been extensive enough to warrant our drawing any very extensive conclusions. The month for convenience has been divided into three parts, early, mid and late. In our later collecting in the mountains careful records have been kept of the elevations at which specimens have been taken and the mountains have been divided into 500 foot zones for this purpose.

The initials of the person collecting the specimen is usually given after each locality and date. These initials refer to the following persons:

*F*ranklin *S*herman, Jr., State Entomologist.
*R. S. W*oglum, formerly Assistant State Entomologist.
*L. M. S*mith, formerly Assistant State Entomologist.
*G. M. B*ently, formerly Assistant State Entomologist.
*C. L. M*etcalf, formerly Assistant State Entomologist.
*C. S. B*rimley, Zoologist, Raleigh.
*A. H. M*anee, Southern Pines.

More collecting has been done at Raleigh than all other points combined but rather extensive collecting has been done at Beaufort, Lake Waccamaw, Southern Pines, Stem, Statesville, Blowing Rock, Yonahlossee Road, Grandfather Mountain, Montreat, Swannanoa, Highlands, Tryon, Canton, Sunburst (Haywood County), Balsam, Waynesville.

Some of our specimens have been identified by Van Duzee, Heideman, Osborn and Ball, but most of the specimens have been examined by the writer and a majority of the species have been identified by him save in the Family Cicadidæ where the identifications stand substantially as made by Mr. Heideman.

FAMILY CICADIDAE

CICADA CANICULARIS, HARRIS (?)

A single specimen from Raleigh seems to be nearer this species than any other. L. Sept. C. S. B.

CICADA LINNEI, S. & G.

Raleigh, Nov. G. M. B.; E. Oct. F. S.; E. Aug. Z. P. M.; L. Sept. G. M. B.

CICADA LYRICEN, DeG.

Raleigh, E. July, F. S. Andrews, L. July, F. S.

CICADA RESONANS, WALK.

Southern Pines. A. H. M.

Cicada auletes, Germ.
Raleigh, Abundant July to Mid. Sept. C. S. B.
Southern Pines, M. Aug. A. H. M.
Lake Toxaway, Mrs. Slosson.

Cicada pruinosa, S. & G.
Beaufort, Mid. Aug. F. S.

Cicada reperta, Uhl.
Wilmington, L. July, J. P. S.

Cicada sayi, S. & G.
Raleigh, L. June to L. Oct. Common.

Cicada septendecem, Linn.
Several distinct broods occur in the State.

Melampsalta parvula, Say.
Southern Pines, June & July, A. H. M.
Aberdeen, June, F. S.
Watkins, E. July. Z. P. M.

Tettigia hieroglyphica, Say.
Beaufort, L. June.
Southern Pines, June and July.
Rocky Mount.

FAMILY MEMBRACIDAE
SUB-FAMILY—SMILIINAE
TRIBE—CERASINI

Acutalis semicrema, Say.
Montreat, L. Sept. 2500-3000 ft. Z. P. M.
Swannanoa, Mid. July. Z. P. M.
Waynesville, Mid. Sept., 2500-3000 ft. Z. P. M.
Stem, E. October. Z. P. M.

Acutalis tartarea, Say.
Raleigh, Mid. October, G. M. B.; L. June, F. S.
Waynesville, Mid. Sept. 3000 ft. Z. P. M.
Waynesville, Rocky Knob. 4000-5000 ft. Mid. Oct. Z. P. M.

CERESA BREVITYLUS, VAN D.
Henderson, June, F. S.
Sunburst, May, 3000-3500 ft. F. S.
Raleigh, E. and Mid. May, Z. P. M.
Raleigh, Mid. April, F. S.

CERESA BOREALIS, FAIRM.
Blowing Rock, Sept. S. W. F.
Yonahlossee Road, Mid. Sept. C. L. M.
Montreat, 2500-3000 ft. L. Sept. Z. P. M.
Balsam, Mid. Sept. 4500-5000 ft. Z. P. M.

CERESA BUBALUS, FABR.
Washington, Mid. July, F. S.
Raleigh, Aug. C. S. B.

CERESA CONSTANS, WALK.
Waynesville, Rocky Knob, 3000-3500 ft. Mid. Sept. Z. P. M.

CERESA DICEROS, SAY.
Marion, Mid. July, F. S.

CERESA ILLINOIENSIS, GODG.
Newton, May, F. S.

CERESA PALMERI, VAN D.
Waynesville, L. Sept., about 3000 ft., Z. P. M.
Balsam, Mid. Sept., 4500-5000 ft., Z. P. M.

CERESA TAURINA, FITCH.
Waynesville, Mid. Sept., 3000 ft., Z. P. M.

CERESA UNIFORMIS, FAIRM.
Balsam, Mid. Sept., 4500-5000 ft., Z. P. M.

MICRUTALIS CALVA, SAY.
Raleigh, L. July, Z. P. M.; E. Sept., F. S.
Balsam, Mid. Sept., 3000 to 5000 ft., Z. P. M.

MICRUTALIS ILLINOIENSIS, GODG.
Raleigh, E. Sept., F. S.; Mid. Sept., Z. P. M.

STICTOCEPHALA DIMINUTA, VAN D.
Raleigh, E. July, F. S.

Stictocephala festina, Say.
Raleigh, E. Oct. to E. Nov., Z. P. M.
Stictocephala inermis, Fabr.
N. C., Z. P. M.
Stictocephala lutea, Walk.
Raleigh, E. Aug., Z. P. M.
Stictocephala rotundata, Stal.
Raleigh, E. Nov., Z. P. M.
Stictocephala substriata, Walk.
N. C., Van D.
Southern Pines, A. H. M.

TRIBE—TELAMONINI, GODG.

Archasia belfragei, Stal.
Southern Pines, A. H. M.
Archasia galeata, Fabr.
Southern Pines, E. June, R. S. W.; Mid. May, A. H. M.

Carynota marmorata, Say.
Raleigh, E. July, Z. P. M.
Blowing Rock, L. July, G. M. B.
Hendersonville, June, F. S.

Carynota mera, Say.
Raleigh, L. Oct., on Pecan, C. L. M.

Carynota porphyrea, Fairm.
Raleigh, Mid. June, F. S.

Heliria cristata, Fairm.
N. C., Van D.

Telamona westcotti, Godg.
N. C., Van D.

Telamona unicolor, Fitch.
Raleigh, Mid. May, H. H. Hume.

Telamona ampelopsidis, Harris.
N. C., Riley.

TELAMONA MONTICOLA, FABR.
N. C., Riley.

THELIA BIMACULATA, FABR.
N. C., Walker.

TRIBE—SMILINI, GODG.

SOMILIA CAMELUS, FABR.
Southern Pines, A. H. M.

ATYMNA CASTANEAE, FITCH.
Cashiers, Mid. June, F. S.

ATYMNA QUERCI, FITCH.
Blowing Rock, L. July, G. M. B.
Highlands, E. Sept., R. S. W.

ATYMNA INORNATA, SAY.
N. C., Van D.

CYRTOLOBUS FENESTRATUS, FITCH.
Raleigh, E. May, Z. P. M.
Blowing Rock, L. June, L. July, F. S.

CYRTOLOBUS MUTICUS, FABR.
N. C., Van D.

CYRTOLOBUS SCULPTUS, FAIRM.
N. C., Van D.

CYRTOLOBUS VAU, SAY.
N. C. Riley.

CYRTOLOBUS DISCOIDALIS, EMM.
Balsam, W. J. Palmer.

CYRTOLOBUS TUBEROSUS, FAIRM.
N. C., Z. P. M.

OPHIDERMA FLAVICEPHALA, GODG.
N. C., Z. P. M.

OPHIDERMA, FLAVA, GODG.
N. C., Z. P. M.

TRIBE POLYGLYPTINI

Entylia bactriana, Germ.
Balsam, L. Sept., 2500-5000 ft., Z. P. M.

Entylia concisa, Walk.
Balsam, Mid. Sept., 4500-5000 ft., Z. P. M.

Entylia sinuata, Fabr.
Stem, E. Oct., Z. P. M.
Balsam, Mid. Sept., 4500-5500 ft., Z. P. M.
Montreat, L. Sept., 2500-3000 ft., Z. P. M.

Publilia concava, Say.
Hendersonville, June, F. S.
Montreat, 2500-3000 ft., L. Sept., Z. P. M.
Black Mountain, L. May, F. S.

Publilia reticulata, Van D.
Hendersonville, June, F. S.
Black Mountain, L. May, F. S.
Balsam, L. Sept., 3500-5000 ft., Z. P. M.
Montreat, 2500-3000 ft., Z. P. M.
Yonahlossee Road, Mid. Sept., C. L. M.

Vanduzea arquata, Say.
Raleigh, Mid. June, Z. P. M.
Montreat, L. Sept., 2500-3000 ft., Z. P. M.
Blowing Rock, L. July, G. M. B.

SUB-FAMILY HOPLOPHORINAE STAL

Platycotis quadrivittata, Say.
Raleigh, E. May, Z. P. M.
Blowing Rock, Sept., S. W. F.

Platycotis sagittata, Germ.
Kawana, Mid. Oct., E. C. Robins.

SUB-FAMILY MEMBRACINAE STAL

Campylenchia latipes, Say.
Raleigh, Mid. June, E. July, L. July, E. Aug., Z. P. M., Mid. Aug., C. L. M.; E. July, F. S.

Waynesville, Rocky Knob, 4000-4500 ft., Mid. Sept., Z. P. M.

ENCHENOPA BINOTATA, SAY.
Montreat, L. Sept., 2500-3000 ft., Z. P. M.

Waynesville, Rocky Knob, Mid. Sept., 4000-5000 ft., Z. P. M.

TYLOPELTA BREVIS, VAN D.
Raleigh, Z. P. M.

SUB-FAMILY CENTROTINAE STAL

MICROCENTRUS CARYAE, FITCH.
Waynesville, Rocky Knob, Mid. Sept., 4500-5000 ft., Z. P. M.

FAMILY FULGORIDAE
SUB-FAMILY FULGORINAE

CYRPOPTUS BELFRAGEI, STAL.
Havelock, L. May, 1907, L. M. S.
Raleigh, E. July, 1909, Z. P. M.

POIOCERA FULIGINOSA, UHLER.
Raleigh, L. Oct., 1902, F. S., on sumach.
Southern Pines, Oct., 1908, A. H. M.

SUB-FAMILY DICTYOPHARINAE

DICTYOPHARA LINGULA, VAN D.
Raleigh, E. to Mid. Aug., Z. P. M.; E. Sept., F. S.

DICTYOPHARA MICRORHINA, WALK.
Southern Pines, Mid. Sept., A. H. M.

PHYLLOSCELIS ATRA, GERM.
Raleigh, L. July, Mid. Sept., Z. P. M.

PHYLLOSCELIS PALLESCENS, GERM.
Raleigh, L. July, Z. P. M. More common than the preceeding.

Scolops angustatus, Uhler.
Highlands of N. C., Uhler.
Raleigh, E. to L. July, Z. P. M.

Scolops dessicatus, Uhler.
Raleigh, E. July, Z. P. M.; E. Oct., F. S.

Scolops perdix, Uhler.
Raleigh, E. July, Z. P. M.

Scolops sulcipes, Say.
Yonahlossee Road, E. Sept., C. L. M.

SUB-FAMILY CIXIINAE

Oliarus humilis, Say.
Raleigh, E. July, Mid. Aug., Z. P. M.

Oliarus quinqucilineatus, Say.
Southern Pines, Mid. May, A. H. M.

Oliarus vicarius, Walk.
Southern Pines, Mid. May, A. H. M.

Oliarus complectus, Ball.
N. C., Z. P. M.

Oecleus decens, Stal.
Raleigh, Mid. June, E. Aug., Z. P. M.
Southern Pines, E. May, A. H. M.

Bothriocera bicornis, Fab.
N. C., Uhler.

Bothriocera tenealis, Burn.
Raleigh, E. July, Mid. July, Z. P. M.; C. L. M.; L. June, F. S.

Cixius stigmatus, Say.
Grandfather Mountain, Mid. Sept., 5000-5500 ft., Z. P. M.

Cixius pini, Fitch.
Raleigh, E. May, Z. P. M.

Myndus pictifrons, Stal.
Hendersonville, July, 1907, F. S.

SUB-FAMILY DELPHACINAE

BOSTAERA NASUTA, BALL.
Southern Pines, L. July, A. H. M.
Willard, L. July, Z. P. M.

STENOCRANUS DORSALIS, FITCH.
Hendersonville, June, F. S.

STENOCRANUS LAUTUS, VAN D.
Raleigh, Mid. Aug., E. Sept., Z. P. M.
Hendersonville, June, F. S.

KELISIA AXIALIS, VAN D.
Stem, E. Oct., Z. P. M.

STOBAERA TRICARINATA, SAY.
Raleigh, L. March, E. Oct.
Statesville, Mid. April, F. S.
Balsam, Mid. Sept., 4000-5000 ft., Z. P. M.
Waynesville, 4000-5000 ft., E. Sept., Z. P. M.

PEREGRINUS MAIDIS, ASH.
Raleigh, L. Sept., C. L. M.

PISSONOTUS BRUNNEUS, V. D.
Raleigh, L. July, F. S.

LIBURNIA PELLUCIDA, FABR.
Raleigh, E. Sept.

LIBURNIA PUELLA, VAN D.
Raleigh, E. Aug., C. L. M.
Grandfather Mountain, about 4000 ft., Sept., F. S.
Hendersonville, June, F. S.
Andrews, Mid. May, F. S.

LIBURNIA ORNATA, STAL.
Raleigh, E. May to E. Nov., Z. P. M.
Stem, E. Oct., Z. P. M.

Grandfather Mountain, 4000-5000 ft., E. Sept., Z. P. M.
Blantyre, May, F. S.
Hendersonville, June, F. S.

Liburnia kilmani, Van D.
Raleigh, Mid. Sept., Z. P. M.

Liburnia consimilis, Van D.
Hendersonville, F. S.

Liburnia laminalis, Van D.
Hendersonville, June, F. S.

SUB-FAMILY ACHILIINAE

Catonia cinctifrons, Fitch.
Balsam, Mid. Sept., 4000-5000 ft., Z. P. M.
Waynesville, Mid. Sept., 3500-4000 ft., Z. P. M.
Montreat, L. Sept., 2500-3500 ft., Z. P. M.

Catonia impunctata, Fitch.
Raleigh, Mid. July, 1912, C. L. M.

Catonia picta, Van D.
N. C., Z. P. M.

Elediptera opaca, Say.
Southern Pines, Mid. Oct., A. H. M.

SUB-FAMILY DERBINAE

Amalopota fitchi, Van D.
Raleigh, L. Aug., Z. P. M.
Red Springs, L. June, F. S.

Anotia burnetii, Fitch.
Raleigh, E. Sept., C. S. B.

Otiocerus coquebertii, Kirby.
Canton, June, F. S.

Lamenia vulgaris, Fitch.
Raleigh, L. May, L. Aug., Z. P. M.
Balsam, Mid. Sept., above 4000 ft., Z. P. M.

Waynesville, Mid. Sept., 3500-4000 ft., Z. P. M.
Beaufort, Mid. June, F. S.

LAMENIA MACULATA, VAN D.
Balsam, Mid. Sept., 4500-5000 ft., Z. P. M.

LAMENIA EDENTULA, VAN D.
Raleigh, Mid. Aug., E. Sept., Z. P. M.

LAMENIA OBSCURA, BALL.
N. C., Van Duzee.

SUB-FAMILY ISSINAE

BRUCHOMORPHA OCULATA, NEWM.
Raleigh, Mid. Aug., Mid. Sept., Z. P. M.

BRUCHOMORPHA DORSATA, FITCH.
Raleigh, Mid. Aug., Z. P. M.

BRUCHOMORPHA SUTURALIS, MEL.
Raleigh, E. Sept., Z. P. M.

BRUCHOMORPHA TRISTIS, STAL.
Raleigh, L. July, Mid. Sept., E. Nov., Z. P. M.

THIONIA BULLATA, SAY.
Raleigh, E., L. July, Z. P. M.
Waynesville, Mid, Sept., at 3000-3500 ft., Z. P. M.
Balsam, Mid. Sept., 4500-5000 ft., Z. P. M.
Andrews, Aug., F. S.

THIONIA SIMPLEX, GERM.
Waynesville, Mid. Sept., 3000-3500 ft., Z. P. M.

THIONIA ELLIPTICA, GERM.
Raleigh, E. July, F. S.

SUB-FAMILY ACANALONINAE

ACANALONIA LATIFRONS, WALK.
Southern Pines, July, S. W. F.

ACANALONIA CONICA, SAY.
Raleigh, L. Oct., C. S. B.

Amphiscepa bivittata, Say.
Raleigh, L. July, E. Aug., Z. P. M.; E. Aug., C.L.M.
Waynesville, Mid. Sept., 3000-3500 ft., Z. P. M.

SUB-FAMILY FLATINAE

Ormenis pruinosa, Say.
Raleigh, E. to L. July, Z. P. M.
Tarboro, Mid. July, F. S.
Statesville, Aug., Z. P. M.
Waynesville, Mid Sept., 3000 to 3500 ft., Z. P. M.

Ormenis septentrionalis, Spin.
Raleigh, E. to L. July, Z. P. M.: Aug., C. S. B.
Statesville, Aug., Z. P. M.
Asheville, Sept., F. S.
Elkin, June, F. S.

Ormenis venusta, Mel.
Raleigh, E. July, F. S.
Southern Pines, Aug., R. S. W.
Statesville, Aug., Z. P. M.

Cyarda melichari, Van D.
Southern Pines, L. May., A. H. M.

FAMILY CERCOPIDAE
SUB-FAMILY CERCOPINAE

Tomaspis rubra, Linn.
Raleigh, L. July to L. Aug., Z. P. M.
Beaufort, E. June, F. S.
Hamlet, L. Oct.,F. S.

SUB-FAMILY APHROPHORINAE

Aphrophora saratogensis, Fitch.
Beaufort, Mid. June, F. S.

Aphrophora signoretii, Fitch.
Blowing Rock, L. June, 4000 to 4500 ft., F. S.

APHROPHORA QUADRINOTATA, SAY.

Highlands, E. Sept.
Canton, June, F. S.
Montreat, L. Sept., 2500-3000 ft., Z. P. M.
Yonahlossee Road, Mid. Sept., C. L. M.

LEPYRONIA QUADRANGULARIS, SAY.

Balsam, Mid. Sept., 4000-5000 ft., Z. P. M.
Waynesville (Rocky Knob), 3000-5000 ft., Z. P. M.
Waynesville, 2500-3500 ft., Z. P. M.
Yonahlossee Road, E. Sept., 4000-5000 ft., Z. P. M.
Grandfather Mountain, about 4000 ft., Z. P. M.

PHILAENUS SPUMARIUS, LINN.

Canton, June, F. S.
Yonahlossee Road, Mid. Sept., 4000-5000 ft., Z. P. M.
Blowing Rock, E. Sept., C. L. M.

CLASTOPTERA OBTUSA, SOY.

Raleigh, L. June, F. S.
Greensboro, Mid. Aug., F. S.
Hendersonville, June, F. S.
Balsam, Mid. Sept., 2500-4000 ft., Z. P. M.
Waynesville, Mid. Sept., 2500-3000 ft., Z. P. M.
Yonahlossee Road, E. Sept., 4000-5000 ft.

CLASTOPTERA PROTEUS, FITCH.

Highlands, July, F. S.
Blowing Rock, July, F. S.

CLASTOPTERA XANTHOCEPHALA, GERM.

Raleigh, Mid. May to E. Nov., Z. P. M.
Beaufort, June, F. S.
Grandfather Mountain, Mid. Sept., 5000-5500 ft., Z. P. M.
Yonahlossee Road, Mid. Sept., C. L. M.
Sunburst, May, 3000-3500 ft., F. S.
Balsam, Mid. Sept., 4000-5000 ft., Z. P. M.
Statesville, Mid. April, F. S.

SUPER-FAMILY JASSOIDEA
FAMILY BYTHOSCOPIDAE

Oncopsis fenestratus, Fitch.
N. C., Van D.

Oncopsis distinctus, Van D.
N. C., Van D.

Oncopsis nigrinasi, Fitch.
N. C., Van D.

Oncopsis variabilis, Fitch.
Blowing Rock, L. July, G. M. B.

Pediopsis viridis, Fitch.
Hendersonville, June, F. S.

Idiocerus alternatus, Fitch.
Southern Pines, Mid. May, H. H. M.

Agallia quadripunctata, Prov.
N. C., Z. P. M.

Agallia sanguinolenta, Prov.
Raleigh, L. Jan., Mid. April, F. S.; Mid. Sept., Z. P. M.
Stem, E. Oct., Z. P. M.
Southern Pines, Jan., F. S.
Balsam, Mid. Sept., 3500 to 4000 ft., Z. P. M.
Grandfather Mountain, about 5000 ft., Mid. Sept., Z. P. M.
Waynesville, about 3000 ft, Z. P. M., Mid. Sept.

Agallia constricta, Van D.
Raleigh, L. July to Mid. Sept., Z. P. M., E. July, F. S.
Hendersonville, June, F. S.
Jefferson, Mid. Aug., F. S.
Grandfather Mountain, about 5000 ft, Mid. Sept. Z. P. M.
Andrews, Mid. May, F. S.

Balsam (Jones' Peak), about 4000 ft., Mid. Sept., Z. P. M.
Waynesville (Rocky Knob), 4000 to 5000 ft., Mid. Sept., Z. P. M.

AGALLIA NOVELLA, SAY.
Raleigh, L. June, Z. P. M.
Hendersonville, June, F. S.
Blowing Rock, L. July, G. M. B.; E., Sept., Z. P. M.
Waynesville, Mid. Sept., 2500 to 3000 ft., Z. P. M.
Balsam, 4500 to 5000 ft., Mid. Sept., Z. P. M.
Andrews, Mid. May, F. S.

FAMILY TETTIGONIELLIDAE
SUB-FAMILY TETTIGONIELLINAE

AULACIZES IRRORATA, FAB.
Hendersonville, June, F. S.
Highlands, E. Sept., R. S. W.
Beaufort, Mid. June, F. S.
Red Springs, L. June, F. S.
Grandfather Mountain, about 4000 ft., F. S.

ONCOMETOPIA UNDATA, FABR.
Raleigh, E. July, F. S.
Beaufort, E. June, F. S.
Ivanhoe, Mid. July, L. M. S.
Lillington, E. June, L. M. S.
Hendersonville, June, F. S.
Highlands, E. Sept., R. S. W.

ONCOMETOPIA LATERALIS, FABR.
Southern Pines, L. March, F. S.; Jan., F. S.; L. June, F. S.
Norlina, Mid. July, S. W. F.
Lake Waccamaw, Mid. April, F. S.
Blowing Rock, Mid. June, F. S.
Statesville, Mid. April, F. S.
Fayetteville, Mid. July, S. W. F.
Red Springs, L. Sept., F. S.

Goldsboro, April, G. M. B.
Stem, E. Oct., Z. P. M.

Tettigoniella gothica, Sign.
Balsam, 3500 to 4000 ft., Mid. Sept., Z. P. M.
Montreat, L. Sept., 2500 to 3000 ft., Z. P. M.
Waynesville, Mid. Sept., about 3000 ft., Z. P. M.
Waynesville (Rocky Knob), Mid. Sept., 3500 to 5000 ft., Z. P. M.

Tettigoniella occatoria, Say.
Raleigh, L. June, Z. P. M.; E. Aug., C. L. M.
Black Mountain, L. May, F. S.

Kolla bifida, Say.
Raleigh, E. May to E. Nov., Z. P. M.
Hendersonville, June, F. S.
Balsam (Jones' Peak), above 4000 ft., Mid. Sept., Z. P. M.
Waynesville, Mid. Sept., Z. P. M., from 2500 to 4000 ft.

Kolla tripunctata, Fitch.
Raleigh, E. Aug., C. L. M.
Waynesville (Rocky Knob), 4000 to 5000 ft., Mid. Sept., Z. P. M.
Balsam, 2500 to 5000, Mid. Sept., Z. P. M.

Helochara communis, Fitch.
Blowing Rock, E. Sept., Z. P. M., 3500 to 4000 ft.
Grandfather Mountain, Mid. Sept., Z. P. M., about 5000 ft.; Mid. Sept., above 4000 ft., F. S.
Balsam, 3500 and 5000 ft., Mid. Sept., Z. P. M.

Diedrocephala coccinea, Forst.
Raleigh, E. Aug., C. L. M.
Highlands, E. July, F. S.
Cane River, Sept., F. S.
Balsam, 4000 to 5000 ft., Z. P. M.
Montreat, 2500 to 3000 ft., L. Sept., Z. P. M.
Wilmington, Mid. May, F. S.

Blowing Rock, L. July, G. M. B.; E. Sept., Z. P. M., 3500 to 4000 ft.
Hendersonville, June, F. S.
Grandfather Mountain, 4000 to 5000 ft., E. Sept., Z. P. M.

DIEDROCEPHALA VERSUTA, SAY.
Raleigh, L. June to E. Aug., Z. P. M.
Charlotte, L. July.
Southern Pines, L. June.
Balsam, 3500 to 4000 ft., Mid. Sept., Z. P. M.
Hendersonville, June, F. S.
Waynesville, about 3000 ft., Mid. Sept., Z. P. M.
Waynesville (Rocky Knob), Mid. Sept., 4000 to 5000 ft., Z. P. M.

DRAECULOCEPHALA MOLLIPES, SAY.
Raleigh, L. March to E. Nov., Z. P. M.
Balsam, Mid. Sept., 3500 to 5000 ft., Z. P. M.
Charlotte, L. July.
Blantyre, E. May, F. S.
Andrews, Mid. May, F. S.
Wallace, L. March, F. S.
Jefferson, Mid. Aug., F. S.
Grandfather Mountain, above 4000 ft., Sept., F. S.
Montreat, L. Sept., 2500 to 3000 ft., Z. P. M.
Stem, E. Oct., Z. P. M.
Swannanoa, Mid. July, Z. P. M.
Waynesville, L. Sept., 2500 to 3000, Z. P. M.

DRAECULOCEPHALA 7-GUTTATA, WALK.
Raleigh, E. Nov., Z. P. M.; E. Aug., C. L. M.

DRAECULOCEPHALA 7 GUTTATA, WALK.
Raleigh, E. July, L. March, Z. P. M.

DRAECULOCEPHALA RETICULATA, SIGN.
Raleigh, E. March, F. S.; L. Sept. to L. Nov,, Z. P. M.
Southern Pines, Jan., F. S.

Eucanthus acuminatus, Fabr.
Canton, June, F. S.

SUB-FAMILY GYPONINA

Xerophloea viridis, Fabr.
Raleigh, L. July, Z. P. M.

Xerophloea major, Bak.
Raleigh, Mid. Sept., E. Oct., Z. P. M.
Yonahlossee Road, Mid. Sept., C. L. M.

Gypona 8-lineata, Say.
Raleigh, E. to Mid. Sept., Z. P. M.
Highlands, Sept., F. S.
Andrews, L. July, F. S.
Southern Pines, L. June, A. H. M.
Waynesville, Mid. Sept., about 3000 ft., Z. P. M.
Balsam, 5000 to 5500, Mid. Sept., Z. P. M.

Gypona striata, Burm.
Raleigh, Mid. Oct., G. M. B.; L. Aug., Z. P. M.
Highlands, E. July, F. S.

Gypona pectoralis, Spangb.
Raleigh, June, F. S.
Cedar Grove, Mid., June, F. S.
Black Mountain, L. May, F. S.

Gypona woodworthi, Van D.
Balsam, Mid. Sept., about 4000 ft., Z. P. M.

Penthemia americana, Fitch.
Black Mountain, L. May, F. S.
Hendersonville, June, F. S.

FAMILY JASSIDAE
SUB-FAMILY ACOCEPHALINA

Xestocephalus pulicarius, Van D.
Waynesville, 2500 to 3000 ft., Z. P. M.

XESTOCEPHALUS TESSELLATUS, VAN D.
N. C., Van D.
Balsam, 4000 to 5000 ft., Mid. Sept., Z. P. M.

SUB-FAMILY JASSINAE

SPANGBERGIELLA VULNERATUS, UHL.
Raleigh, L. June to L. Aug., Z. P. M.

PARABOLOCRATUS FLAVIDUS, SIGN.
Raleigh, L. June to E. Sept., Z. P. M.

PLATYMETOPIUS CINEREUS, O. & B.
N. C., Z. P. M.

PLATYMETOPIUS CUPRESCENS, OSB.
N. C., Z. P. M.

PLATYMETOPIUS ACUTUS, SAY.
Raleigh, L. May, F. S.
Hendersonville, June, F. S.
Waynesville (Rocky Knob), 4000 to 5000 ft., Mid. Sept., Z. P. M.
Balsam, 4000 to 5000 ft., Mid. Sept., Z. P. M.

PLATYMETOPIUS FRONTALIS, VAN D.
Raleigh, L. June, F. S.
Andrews, Mid. May, F. S.

PLATYMETOPIUS VERECUNDUS, VAN D.
N. C., Z. P. M.

EUTETTIX SUBAENEA, VAN D.
Raleigh, Mid. Aug., Mid. Sept., E. Nov., Z. P. M.; E. July, F. S.
Swannanoa, Mid. July, Z. P. M.
Waynesville (Rocky Knob), Mid. Sept., Z. P. M., 3500 to 4000 ft.

EUTETTIX SEMINUDA, SAY.
Raleigh, Mid. July, F. S.; Early July, Z. P. M.

EUTETTIX MODESTA, O. & B.
N. C., Fisk.

Phlepsius superbus, Van D.
N. C., Van D.

Phlepsius excultus, Uhl.
Raleigh, E. July, F. S.

Phlepsius truncatus, Van D.
N. C., Van D.

Phlepsius irroratus, Say.
Raleigh, Early June, F. S.; Mid. July, F. S.; L. May, F. S.
Hendersonville, June, F. S.
Whiteville, L. July, R. S. W.

Phlepsius fulvidorsum, Fitch.
N. C., Z. P. M.

Acinopterus acuminatus, Van D.
N. C., Van D.
Raleigh, E. July to E. Nov., Z. P. M.
Stem, E. Oct., Z. P. M.

Scaphoideus sanctus, Say.
Raleigh, E. Aug., C. L. M.

Scaphoideus auronitens, Prov.
Montreat, 2500 to 3000 ft., L. Sept., Z. P. M.
Balsam, 4500 to 5000 ft., Mid. Sept., Z. P. M.

Scapoideus jucundus, Uhl.
Raleigh, Mid. Sept., Z. P. M.
Tryon, Fisk.

Scaphoideus consors, Uhl.
Tryon, Fisk.

Scaphoideus lobatus, Van D.
Balsam, Mid. Sept., Z. P. M.

Scaphoideus productus, Osb.
Balsam, 4500-5000, Z. P. M.
Tryon, Fisk.

SCAPHOIDEUS CARINATUS, OSB.
Tryon, Fisk.
Black Mountain, Beutenmuller.

SCAPHOIDEUS NIGRICANS, OSB.
Raleigh, L. May, Z. P. M. (Type locality).

SCAPHOIDEUS IMMISTUS, SAY.
Raleigh, E. Aug., Z. P. M.
Waynesville (Rocky Knob), Mid. Sept., 3500 to 4000 ft., Z. P. M.

DELTOCEPHALUS REFLEXUS, O. & B.
Raleigh, L. June, Mid. Aug., Mid. Sept., E. Oct., E. Nov., Z. P. M.

DELTOCEPHALUS SAYI, FITCH.
Grandfather Mountain, Mid. Sept., about 5000 ft., Z. P. M.

DELTOCEPHALUS MINIMUS, O. & B.
Andrews, Mid. May, F. S.

DELTOCEPHALUS INIMICUS, SAY.
Raleigh, L. Aug., Z. P. M.
Blowing Rock, E. Sept., 3500 to 4000 ft., Z. P. M.
Grandfather Mountain, 4000 to 5000 ft., Mid. Sept., Z. P. M.
Balsam (Jones' Peak), about 4000 ft., Z. P. M.; 4000 to 5000 ft., Z. P. M.

DELTOCEPHALUS WEEDI, VAN D.
Raleigh, Mid. Sept., E. Oct., E. July, L. July, E. Oct., Z. P. M.; E. Sept., F. S.
Stem, E. Oct., Z. P. M.
Grandfather Mountain, about 5000 ft., Mid. Sept., Z. P. M.
Waynesville, E. Sept., Z. P. M.
Balsam, 4500 to 5000 ft., Mid. Sept., Z. P. M.

DELTOCEPHALUS COMPACTUS, OSB.
Raleigh, Mid. Sept., Z. P. M.

Deltocephalus flavocostatus, Van D.
Raleigh, L. June, E. Sept., F. S.
Balsam, about 4000 ft., Mid. Sept., Z. P. M.
Hendersonville, June, F. S.
Waynesville, Mid. Sept., 2500 to 3000 ft., Z. P .M.

Deltocephalus obtectus, O. & B.
Raleigh, L. June, F. S.; Mid. June to L. Aug., Z. P. M.

Deltocephalus perpunctatus, Van D.
N. C., F. S.

Deltocephalus areolatus, Ball.
Raleigh, Mid. Aug., E. Nov., Z. P. M.

Deltocephalus sylvestris, O. & B.
Raleigh, E. Nov., Z. P. M.
Andrews, Mid. May, F. S.

Deltocephalus nigrifrons, Forbes.
Raleigh, E. July to E. Nov., Z. P. M.
Grandfather Mountain, about 5000 ft., Mid. Sept., Z. P. M.
Balsam, 3500 to 5000 ft., Mid. Sept., Z. P. M.
Andrews, Mid. May, F. S.
Stem, E. Oct., Z. P. M.

Goniagnathus palmeri, Van D.
N. C., Van D.
Raleigh, E. Aug., C. L. M.; E. July, Z. P. M.

Athysanus exitiosus, Uhl.
Raleigh, Mid. Sept., L. July, Z. P. M.; E. July, L. March, F. S.
Waynesville (Rocky Knob), Mid. Sept., Z. P. M.
Statesville, April, F. S.
Hendersonville, June, F. S.
Stem, E. Oct., Z. P. M.
Balsam (Jones' Peak), about 4000 ft., Mid. Sept., Z. P. M.

ATHYSANUS CURTISII, FITCH.
Grandfather Mountain, 4000 ft., E. Sept., F. S.
Waynesville, 2500 to 3000 ft., Mid. Sept., Z. P. M.

ATHYSANUS BICOLOR, VAN D.
Raleigh, Mid. June, E. July, E. Sept., F. S.
Stem, E. Oct., Z. P. M.

ATHYSANUS OBTUTUS, VAN D.
Raleigh, E. Nov., Z. P. M.; Mid. April, F. S.; E. March, L. March, Z. P. M.
Statesville, Mid. April, F. S.
Balsam, 5000 to 5500 ft., Mid. Sept., Z. P. M.

THAMNOTETTIX CLITELLARIUS, SAY.
Raleigh, Mid. May, Z. P. M.
Balsam, Mid. Sept., 3500 to 4000 ft., Z. P. M.
Franklin, Mid. May., F. S.

THAMNOTETTIX KENNICOTTI, UHL.
Raleigh, E. Aug., C. L. M.; E. July, F. S.; L. July, E. Nov., Z. P. M.
Hendersonville, June, F. S.
Balsam, Mid. Sept., 4500 to 5000 ft., Z. P. M.

THAMNOTETTIX FITCHI, VAN D.
Hendersonville, June, F. S.
Jefferson, Mid. Aug., F. S.

THAMNOTETTIX BRITTONI, OSB.
N. C., Z. P. M.

CHLOROTETTIX VIRIDIA, VAN D.
N. C., Van D.
Raleigh, E. July to E. Nov., Z. P. M.
Stem, E. Oct., Z. P. M.
Balsam, Mid. Sept., about 4000 ft., Z. P. M.

CHLOROTETTIX GALBANATA, VAN D.
Raleigh, L. June, Z. P. M.
Waynesville, 2500 to 3000 ft., Mid. Sept.

Chlorotettix spatulata, O. & B.
Raleigh, Mid. Aug., Z. P. M.

Chlorotettix necopina, Van D.
Raleigh, E. July to Mid. Sept., Z. P. M.

Jassus olitorius, Say.
Raleigh, E. Aug. to E. Nov., Z. P. M.
Whiteville, July, R. S. W.
Highlands, E. Sept., R. S. W.
Andrews, Aug. F. S.,
Stem, E. Oct., Z. P. M.
Montreat, 2500 to 3000 ft., L. Sept., Z. P. M.
Grandfather Mountain, 5000 to 5500 ft., Mid. Sept., Z. P. M.
Lake Waccamaw, Mid. April, F. S.
Waynesville, Mid. Sept., about 3000 ft., Z. P. M.
Balsam, Mid. Sept., 4500 to 5000 ft., Z. P. M.
Balsam (Jones' Peak), 4500 to 5000 ft., Mid. Sept., Z. P. M.

Tinobregmus vittatus, Van D.
Beaufort, E. June, F. S.

Balclutha punctatus, Thumbg.
Blantyre, E. May, F. S.

Eugnathodus abdominalis, Van D.
N. C., F. S.

Cicadula 6-notata, Fall.
Raleigh, E. Aug., Z. P. M.
Hendersonville, June, F. S.
Blowing Rock, 3500 to 4000, E. Sept., Z. P. M.
Grandfather Mountain, about 5000 ft., Sept., Z. P. M.
Balsam, Mid. Sept., 3500 to 4000, Z. P. M.
Stem, E. Oct., Z. P. M.

Cicadula slossoni, Van D.
Balsam, Mid. Sept., 4500 to 5000, Z. P. M.
Hendersonville, June, F. S.

PARACOELIDIA TUBERCULATA, G. & B.
Raleigh, L. June, R. S. W.

DRIATURA ROBUSTA, O. & B.
Raleigh, E., L. July, E., Mid. and L. Aug., Z. P. M.; Mid. Aug., C. L. M.

DRIATURA GAMMAROIDEA, VAN D.
Raleigh, L. July, Mid. and L. Aug., Z. P. M.

SUB-FAMILY TYPHLOCYBINA

EMPOASCA VIRIDESCENS, WALSH.
Raleigh, E. Aug., Z. P. M.

EMPOASCA MALI, LE B.
Hendersonville, June, F. S.

EMPOASCA SPLENDIDA, GILL.
Hendersonville, June, F. S.

DICRANEURA ABNORMIS, WALSH.
Raleigh, L. March, Z. P. M.

DICRANEURA FIEBERI, LOW.
Raleigh, Mid. April, F. S.
Blantyre, E. May, F. S.

TYPHLOCYBA COMES, SAY.
Raleigh, Mid. Aug., F. S.; Mid. Sept., Z. P. M.

TYPHLOCYBA TRICINCTA, FITCH.
Raleigh, Mid. Sept., Z. P. M.

TYPHLOCYBA ILLINOIENSIS, GILL.
Southern Pines, Jan. and E. July, F. S.

THE SEASONAL DISTRIBUTION OF THE ARMY-WORM MOTH AT RALEIGH

BY C. S. BRIMLEY

During the summer of 1914 there was an outbreak of the army-worm (Leucania unipuncta) in North Carolina and at the suggestion of Mr. Franklin Sherman, our State entomologist, I kept a record of the number of moths of this species caught in a "sugar" baited moth trap which I run more or less every summer. The idea was to get some data as to the variation in numbers of the species, as well as to how late it flew in the fall and when it appeared again in the spring.

Before these observations my records simply showed that the moths of this species occurred at Raleigh from early May to late November without a break.

The observations were begun on August 13, 1914, and have continued till the present time (May 7, 1915), the moths all being caught in a modification of the old fashioned fly trap, but made larger and of curtain net instead of wire cloth. This trap is suspended from the limb of a tree and is baited usually with a mixture of molasses and water allowed to ferment and placed in a small tin bucket covered with net to prevent the moths drowning themselves in it.

I was not able to take time to count the moths on every night the trap was set and during the winter the trap was only set on warm nights when there was a likelihood of moths of some species being on the wing.

CATCH OF MOTHS

Date	Army-worm Moths	Other Moths	Per cent of Army-worm Moths
August 13, 1914	61	21	75
August 14, 1914	53	11	84
August 15, 1914	27	10	73
August 16, 1914	74	29	71
August 17, 1914	77	25	75
August 19, 1914	15	7	68

Date	Army-worm Moths	Other Moths	Per cent of Army-worm Moths
August 20, 1914	153	18	89
September 4, 1914	35	19	64
September 19, 1914	3	7	30
September 21, 1914	7	15	33
September 22, 1914	55	46	54
September 23, 1914	36	49	42
September 28, 1914	7	19	27
September 29, 1914	15	7	68
September 30, 1914	13	30	30
October 1, 1914	14	14	50
October 8, 1914	27	10	73
October 26, 1914	3	1	75
October 30, 1914	7	0	100
October 31, 1914	4	0	100
November 3, 1914	4	0	100
November 4, 1914	11	1	92
November 5, 1914	22	5	81
November 7, 1914	6	0	100
November 8, 1914	9	3	75
November 9, 1914	26	2	93
November 12, 1914	1	0	100
November 14, 1914	3	0	100
November 16, 1914	10	5	67
November 26, 1914	1	1	50
November 27, 1914	7	0	100
November 28, 1914	4	0	100
November 29, 1914	3	0	100
November 30, 1914	7	0	100
December 2, 1914	38	2	95
December 3, 1914	24	1	96
December 4, 1914	53	2	96
December 5, 1914	17	1	94
December 22, 1914	1	0	100
April 17, 1915	1	1	50
April 19, 1915	1	0	100
April 20, 1915	4	7	36
May 3, 1915	1	8	11
May 5, 1915	2	9	18
May 6, 1915	1	3	25

REMARKS ON ABOVE TABLE

August 19, added fruit juice and a little molasses to bait. About as many in trap on August 21 and 28 as on August 20

and about same proportion of army-worm moths. About 50 arm-worm moths in trap on September 6, and about 20 to 25 during following week, then numbers decidedly decreased. Several inches of snow fell on night of November 19, following a killing frost on November 17, which killed all remaining susceptible vegetation, weather continued comparatively cold till November 25. Between Demeber 5 and 22 the weather was either wet or cold, the minimum temperature dropping as low as 16 or 17 for two or three days. From December 23 to April 16 inclusive the trap was set nine times, catching 22 moths, including 1 cutworm moth, but no army-worm moths. Between April 21 and May 2 inclusive, the trap was set eight times, catching 43 moths, including 11 cutworms moths (Agrotis ypsilon and Peridroma saucia) but no army-worm moths. On May 4, eight other moths were caught.

The army-worm moths caught in April and May have with one or two exceptions been very evidently worn specimens.

RALEIGH, N. C.